From: <kulczyckyt@nimo.com>
To: WND2.WNP5(JJH),WND2.WNP3(DSH)
Date: 5/22/98 12:10pm
Subject: Evaluation - JAF DBA impact on NMP1 control room.

Darl/Jack,

The attached evaluation assesses the impact of a Design Basis Accident at the James A. Fitzpatrick Nuclear Plant
on the control room at Nine Mile Point Unit 1.

(See attached file: jaf.doc)

The document is in WORD for Windows version 7.0 format - if unable to read please call. My number is 315-349-1949 or try my pager 1-800-732-4365, pager # 1072.

Ted Kulczycky

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Do we agree w/ the Fitzpatrick EAB value?

Evaluation of the Impact

of a Design Basis Accident At the James A. Fitzpatrick Nuclear Plant

On the Control Room At Nine Mile Point, Unit 1

Prepared by:

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Reviewed by:

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Date

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OBJECTIVE

The objective of this evaluation is to demonstrate that the dose to operators in the Nine Mile Point Unit 1 control room following a Design Basis Accident at the James A Fitzpatrick Nuclear Plant are within the limits specified in GDC 19.

METHOD

Chapter 14 of the James A. Fitzpatrick (JAF) Final Safety Analysis Report (FSAR) [Reference 1] contains doses due to releases from four design basis accidents:

Loss-of-Coolant Accident (LOCA),
Main Steam Line Break (MSLB),
Control Rod Drop Accident (CRDA), and
Refueling Accident (RA).

Results are presented for the two hour dose at the site boundary, the 30 day dose at the Low Population Zone (LPZ), and the 30 day dose to the operators in the JAF control room and Technical Support Center.

The control room for Nine Mile Point Unit 1 (NMP1) is located a considerable distance from JAF, so any releases from JAF will undergo significant atmospheric dispersion before reaching the NMP1 control room intake. Since the site boundary and LPZ doses are directly proportional to atmospheric dispersion, these doses are used to estimate the NMP1 control room operator dose using the following three steps:

1. Develop a conservative estimate for the atmospheric dispersion parameters (also known as χ/Q) at the NMP1 control room intake for releases from JAF.
2. Scale the JAF site boundary or LPZ dose, as appropriate, by the ratio of the χ/Q's to estimate the unprotected dose at the NMP1 control room intake.
3. Adjust the unprotected dose rate for protection afforded by the control room and control room ventilation system (if appropriate) to produce a final estimate of the control room operator dose.

ACCEPTANCE CRITERIA

The acceptance criteria for the operator dose is from General Design Criteria 19 (GDC 19), Appendix A, 10CFR50 [Reference 2]. The dose limit for control room operators following an accident is 5 rem whole body or the equivalent. Standard Review Plan (SRP) 6.4 [Reference 3] defines the equivalent thyroid dose as 30 rem and the equivalent beta skin dose as 30 rem.

DATA/ASSUMPTIONS

1. The atmospheric dispersion parameters (χ/Q, sec/m3) for concentrations at the site boundary due to releases from JAF are from Table 14.8-5 of the JAF FSAR:

Stack Release: 5.24E-5 ✓ 5.1E-5 ✓

Turbine Building Release: 1.79E-4 ✓ 1.3E-4 ✓

4.29

are these direction independent calcs?

2. The atmospheric dispersion parameters for concentrations at the LPZ due to stack releases from JAF are from Table 14.8-5 of the JAF FSAR:

Time Period	χ/Q (sec/m3)	
0-2 hrs	2.04E-5	?
4-8 hrs	2.17E-6	2.0E-5
8-24 hrs	9.53E-7	6.2E-6
24-96 hrs	3.90E-7	?
96-744 hrs	1.38E-7	?

what about these 2-4?

why do we differ by an order of magnitude?

These may be direction independent values

3. The site boundary (0-2 hr) doses in rem for the following accidents are taken from Table 14.8-8 of the JAF FSAR:

	Thyroid	Wh. Body	Skin
MSLB	7.563E-1	4.249E-3	6.709E-3
CRDA	3.191E-1	1.312E-2	2.514E-2
RA	1.109E-1	9.092E-2	2.101E-1

4. The LPZ (0-30 day) doses in rem for the LOCA are taken from Table 14.8-9 of the JAF FSAR:

	Thyroid	Wh. Body	Skin
Drywell Leak	1.032E+1	1.711E+0	2.901E+0
ESF Leakage	8.853E-1	2.521E-2	3.773E-2
Total (30 days)	1.121E+1	1.736E+0	2.939E+0

5. The time dependent LPZ doses for the LOCA are taken from Tables 4.1 and 4.2 of calculation JAF-CALC-RAD-00048, Rev. 0 [Reference 4]:

	Drywell Leakage Dose (rem)		
Time (hr)	Thyroid	Whole Body	Skin
2	3.900E+00	8.446E-01	1.482E+00

4	7.564E+00	1.344E+00	2.314E+00
8	8.291E+00	1.500E+00	2.541E+00
24	8.838E+00	1.645E+00	2.771E+00
96	9.735E+00	1.699E+00	2.872E+00
744	1.032E+01	1.711E+00	2.901E+00

ESF Component Leakage Dose (rem)

Time (hr)	Thyroid	Whole Body	Skin
2	2.663E-01	3.368E-03	5.231E-03
4	5.821E-01	1.105E-02	1.733E-02
8	6.513E-01	1.574E-02	2.389E-02
24	7.104E-01	2.320E-02	3.461E-02
96	8.134E-01	2.512E-02	3.754E-02
744	8.853E-01	2.521E-02	3.773E-02

6. The site boundary for JAF is located 3000 ft to the east of the plant, as stated in Section 2.1 of the JAF Emergency Plan [Reference 5].

7. The survey coordinates for the center of the reactor containments are taken from Reference 6:

JAF	N1,283,450	E549,000
NMP1	N1,283,173	E545,760

8. The following adjustment factors for variations in wind speed, wind direction and control room occupancy are taken from the paper by Murphy-Campe [Reference 7]:

Adjustment Factors for Calculating Relative Concentrations

Factor	0-8 hrs	8-24 hrs	1-4 days	4-30 days
Occupancy	1	1	0.60	0.40
Wind Speed	1	0.67	0.50	0.33
Wind Direction	1	0.88	0.75	0.50
Overall Reduction	1	0.59	0.23	0.066

9. The following parameters characterize the control room emergency ventilation system, which is assumed to be initiated within two hours following the LOCA at JAF [Reference 10]:

Makeup rate (cfm)	2500
Makeup filter efficiency	0.90
Unfiltered inleakage rate (cfm)	30
Control room volume (ft3)	1.31E+5

EVALUATION

ATMOSPHERIC DISPERSION PARAMETERS (χ/Q)

The site boundary χ/Q in item 1 under DATA/ASSUMPTIONS is calculated for the east boundary, which is located 3,000 ft from the release point. The east-west distance between the containment center lines for JAF and NMP1 is simply the difference between the east survey coordinates, or

549,000 - 545,760 = 3,240 ft

The distance from the JAF containment center to the control room intake will be about 200 ft less than this, since the control room is located to the east of the containment [Reference 8]. There will also be a slight increase in this distance because of the difference in north survey coordinates, but the conclusion is that the distance is slightly greater than 3,000 ft. Therefore the distance from the JAF release points to the NMP1 control room intakes is essentially the same as the distance from the JAF release point to the site boundary. Since the prevailing wind is from the west-southwest, as shown in Table 2B-10 from the NMP Unit 2 FSAR [Reference 9], the χ/Q for this sector (which is representative of 95 percentile atmospheric conditions) would bound the χ/Q for the same distance in other sectors. Therefore, the site boundary χ/Q is assumed to bound the 95th percentile χ/Q for the NMP1 control room intake.

To determine the χ/Q's for periods longer than 2 hours, the correction factors from Murphy-Campe are applied to the initial χ/Q (DATA/ASSUMPTIONS item 1):

Time Period	χ/Q (sec/m3)
0-2 hrs	5.24E-5
4-8 hrs	5.24E-5
8-24 hrs	3.10E-5
24-96 hrs	1.21E-5
96-744 hrs	3.47E-6

NMP1 CONTROL ROOM DOSES

Unprotected MSLB, CRDA and RA Control Room Doses

The doses due to the MSLB, CRDA and RA occur over a period of two hours, so there would be no adjustment to the atmospheric dispersion parameters. Therefore, the doses to the NMP1 control room operators would be the same as the site boundary doses if no credit is taken for the protective features of the control room, including the ventilation system and shielding afforded by the control room walls. From DATA/ASSUMPTIONS item 3, the doses are:

Unprotected NMP1 Control Room Doses (rem)			
	Thyroid	Wh. Body	Skin
MSLB	7.563E-1	4.249E-3	6.709E-3
CRDA	3.191E-1	1.312E-2	2.514E-2
RA	1.109E-1	9.092E-2	2.101E-1

Unprotected LOCA Control Room Doses

Estimating the NMP1 control room doses resulting from a LOCA at JAF is more complicated than the other accidents because the duration of the LOCA is 30 days and adjustments need to be made for variations in atmospheric dispersion. To determine this adjustment, it is noted that the total dose is the sum of doses during each of the time intervals, or

$$Dtotal = \Sigma i\ Di$$

where the thyroid dose in time interval i is

$$Di = (\chi/Q)i\ Bi\ \Sigma k\ Qi,k\ DCFk$$

and

Bi = breathing rate in time period i,
Qi,k = release of nuclide k in time period i, and
DCFk = dose conversion factor for nuclide k.

The whole body and skin doses are similar except there is no breathing rate and the dose conversion factors are different. Since the releases don't change, the impact of changes in atmospheric dispersion and breathing rate can be estimated by determining the fraction of the dose that is received during each time interval and scaling that fraction by the ratio of the χ/Q and breathing rates. The scaling factor for each time interval is therefore:

	LPZ		NMP1 Control Room		Scale Factor	
Time Period	X/Q	B	X/Q	B	Thyroid	WB/Skin
0-2 hrs	2.04E-05	3.47E-04	5.24E-05	3.47E-04	2.57	2.57
4-8 hrs	2.17E-06	3.47E-04	5.24E-05	3.47E-04	24.15	24.15
8-24 hrs	9.53E-07	1.75E-04	3.10E-05	3.47E-04	64.50	32.53
24-96 hrs	3.90E-07	2.32E-04	1.21E-05	3.47E-04	46.40	31.03
96-744 hrs	1.38E-07	2.32E-04	3.47E-06	3.47E-04	37.61	25.14

Using the time dependent doses in DATA/ASSUMPTIONS item 5, which are cumulative doses, the dose fraction in each interval is calculated and then adjusted by the scale factor to determine the overall change in the dose:

Unprotected Dose Adjustment Factors, LOCA Drywell Leakage

	LPZ Dose Fraction			NMP1 Control Room		
Time Period	Thyroid	Wh. Body	Skin	Thyroid	Wh. Body	Skin
0-2 hrs	3.78E-01	4.94E-01	5.11E-01	9.71E-01	1.27E+00	1.31E+00
2-4 hrs	3.55E-01	2.92E-01	2.87E-01	9.12E-01	7.50E-01	7.37E-01
4-8 hrs	7.04E-02	9.12E-02	7.82E-02	1.70E+00	2.20E+00	1.89E+00
8-24 hrs	5.30E-02	8.47E-02	7.93E-02	3.42E+00	2.76E+00	2.58E+00
24-96 hrs	8.69E-02	3.16E-02	3.48E-02	4.03E+00	9.79E-01	1.08E+00
96-744 hrs	5.67E-02	7.01E-03	1.00E-02	2.13E+00	1.76E-01	2.51E-01
Total	1.00E+00	1.00E+00	1.00E+00	1.32E+01	8.13E+00	7.85E+00

Unprotected Dose Adjustment Factors, LOCA ESF Leakage

	LPZ Dose Fraction			NMP1 Control Room		
Time Period	Thyroid	Wh. Body	Skin	Thyroid	Wh. Body	Skin
0-2 hrs	3.01E-01	1.34E-01	1.39E-01	7.73E-01	3.43E-01	3.56E-01
2-4 hrs	3.57E-01	3.05E-01	3.21E-01	9.16E-01	7.83E-01	8.24E-01
4-8 hrs	7.82E-02	1.86E-01	1.74E-01	1.89E+00	4.49E+00	4.20E+00
8-24 hrs	6.68E-02	2.96E-01	2.84E-01	4.31E+00	9.63E+00	9.24E+00
24-96 hrs	1.16E-01	7.62E-02	7.77E-02	5.40E+00	2.36E+00	2.41E+00
96-744 hrs	8.12E-02	3.57E-03	5.04E-03	3.05E+00	8.98E-02	1.27E-01
Total	1.00E+00	1.00E+00	1.00E+00	1.63E+01	1.77E+01	1.72E+01

The LPZ 30 day doses (DATA/ASSUMPTIONS item 4) are multiplied by these adjustment factors to obtain an estimate of the unprotected doses in the control room:

Unprotected NMP1 Control Room Doses LOCA (rem)

	Thyroid	Wh. Body	Skin
Drywell Leak	1.36E+02	1.39E+01	2.28E+01
ESF Leakage	1.45E+01	4.46E-01	6.47E-01
Total (30 days)	1.50E+02	1.44E+01	2.34E+01

Note that the thyroid and whole body doses are significantly higher than their respective 30 rem and 5 rem limits. Therefore, to meet the requirements of GDC 19, the protective features of the control room must be considered.

Protected LOCA NMP1 Control Room Doses

The effectiveness of the control room ventilation system can be characterized by the iodine protection factor (IPF) as described in Murphy-Campe. Since the control room ventilation system at NMP1 does not have filtered recirculation, the IPF is

$$IPF = (F1 + F3)/[(1-\eta)F1 + F3]$$

where

F1 = filtered makeup rate (2500 cfm),
F3 = unfiltered inleakage rate (30 cfm), and
η = makeup filter efficiency (0.9).

The IPF for the NMP1 control room is therefore

$$IPF = (2500 + 30)/([1-.9]2500 + 30) = 9.04$$

The whole body dose can also be adjusted for the finite volume in the control room using the geometry factor in Murphy-Campe:

$$GF = 1173/V0.338$$

where V is the control room volume (1.31E+5 ft3). Using this value,

$$GF = 1173/(1.31E+5)0.338 = 21.9$$

The unprotected dose adjustment factors are then modified by dividing the values for the thyroid dose by IPF (except for the first two hour period) and dividing the whole body dose by the geometry factor. Note that the skin dose is not affected by either the geometry factor or IPF. The resulting adjustment factors are shown below:

Protected NMP1 Control Room Dose Adjustment Factors

	Drywell Leakage			ESF Leakage		
Time Period	Thyroid	Wh. Body	Skin	Thyroid	Wh. Body	Skin
0-2 hrs	9.71E-01	5.79E-02	1.31E+00	7.73E-01	1.57E-02	3.56E-01
2-4 hrs	1.01E-01	3.42E-02	7.37E-01	1.01E-01	3.57E-02	8.24E-01
4-8 hrs	1.88E-01	1.01E-01	1.89E+00	2.09E-01	2.05E-01	4.20E+00
8-24 hrs	3.78E-01	1.26E-01	2.58E+00	4.76E-01	4.40E-01	9.24E+00
24-96 hrs	4.46E-01	4.47E-02	1.08E+00	5.97E-01	1.08E-01	2.41E+00
96-744 hrs	2.36E-01	8.05E-03	2.51E-01	3.38E-01	4.10E-03	1.27E-01
Total	2.32E+00	3.71E-01	7.85E+00	2.49E+00	8.08E-01	1.72E+01

These adjustment factors are then applied to the LPZ 30 day LOCA doses to produce the expected control room doses:

Protected NMP1 Control Room Doses LOCA (rem)

	Thyroid	Wh. Body	Skin
Drywell Leak	2.39E+01	6.35E-01	2.28E+01
ESF Leakage	2.21E+00	2.04E-02	6.47E-01
Total (30 days)	2.61E+01	6.56E-01	2.34E+01

All of these doses are within the limits of GDC 19.

Post LOCA Shine from the JAF Secondary Containment

The impact on the site boundary of the direct dose from the JAF secondary containment above the refueling floor is not addressed in the JAF FSAR. However, the calculation at Reference 4 provides calculated dose rates as a function of time at various point on the JAF site. The farthest point is labeled number #10 and is approximately 270 meters from the reactor building. To determine the impact of the direct dose on the NMP1 control room, the dose is integrated over 30 days, as shown below. This dose is then reduced by a factor of 3.4 to account for the increased distance. This factor is the ratio of 3000 ft to 270 meters, which is equivalent to assuming the dose rate falls off linearly as a function of distance. The doses are also multiplied by Murphy-Campe occupancy factors from DATA/ASSUMPTIONS item 8. This produces the dose in the last column below:

Estimated Unshielded Shine Dose at NMP1 Control Room

Time	Dose Rate # 10, rad/hr	Dose, #10, rad	NMP1 Dose w/occ, rad
0	0.00E+00	0.00E+00	0.00E+00
0.5	1.02E-01	2.55E-02	7.49E-03
1	1.55E-01	8.97E-02	2.64E-02
2	2.12E-01	2.73E-01	8.03E-02
4	2.41E-01	7.25E-01	2.13E-01
8	2.12E-01	1.63E+00	4.80E-01
12	1.73E-01	2.40E+00	7.06E-01
18	1.29E-01	3.31E+00	9.73E-01
24	9.93E-02	3.99E+00	1.17E+00
36	6.35E-02	4.97E+00	1.35E+00
48	4.45E-02	5.62E+00	1.46E+00
72	2.73E-02	6.48E+00	1.61E+00
96	2.02E-02	7.05E+00	1.71E+00
168	1.24E-02	8.22E+00	1.85E+00
336	5.82E-03	9.75E+00	2.03E+00
744	1.02E-03	1.11E+01	2.20E+00

The dose of 2.20 rad, when added to the the LOCA whole body dose, is within the GDC 19 limits. It should be noted that this does not include credit for any intervening shielding. As a minimum, the control room wall will reduce the shine dose well below 1 rem. Other structures, such as the buildings at NMP Unit 2, may eliminate the direct dose altogether.

RESULTS/CONCLUSIONS

The doses to operators in the NMP1 control room following design basis accidents at JAF are summarized below. Inspection of these results indicates the doses are all within the limits of

GDC 19.

NMP1 Control Room Doses (rem) due to Accidents at JAF

Accident	Thyroid	Wh. Body	Skin
MSLB	7.563E-1	4.249E-3	6.709E-3
CRDA	3.191E-1	1.312E-2	2.514E-2
RA	1.109E-1	9.092E-2	2.101E-1
LOCA	2.61E+01	6.56E-01	2.34E+01
GDC 19 Limit	30	5	30

The evaluation of these accidents is based on the assumption that the site boundary short term atmospheric dispersion parameter for JAF is a reasonable estimate for the atmospheric dispersion from JAF to the NMP1 control room intake. This assumption is based on the fact that the distance from JAF to the site boundary is nearly identical to the distance from JAF to the NMP1 control room intake, and the prevailing wind direction is from the west.

For the MSLB, CRDA and RA, no credit is taken for the control room ventilation system. For the LOCA, the control room ventilation system is assumed to be initiated 2 hours after the start of the accident at JAF. Earlier initiation of the ventilation system may reduce the thyroid dose by as much as one-third.

REFERENCES

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"Control Room," General Design Criteria 19, Appendix A, 10CFR50

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"Plot Plan," Drawing No. 12177-EM-1A-3, Nine Mile Point Nuclear Station, Unit 2, Niagra Mohawk Power Corporation

Murphy, K. G., and Campe, K. M., "Nuclear Power Plant Control Room Ventilation System Design for Meeting General Criterion 19," 13th AEC Air Cleaning Conference, August 1974

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